Full-sky Astrometric Mapping Explorer

http://www.usno.navy.mil/fame

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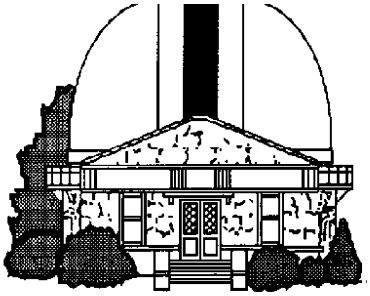

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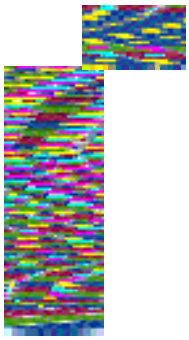

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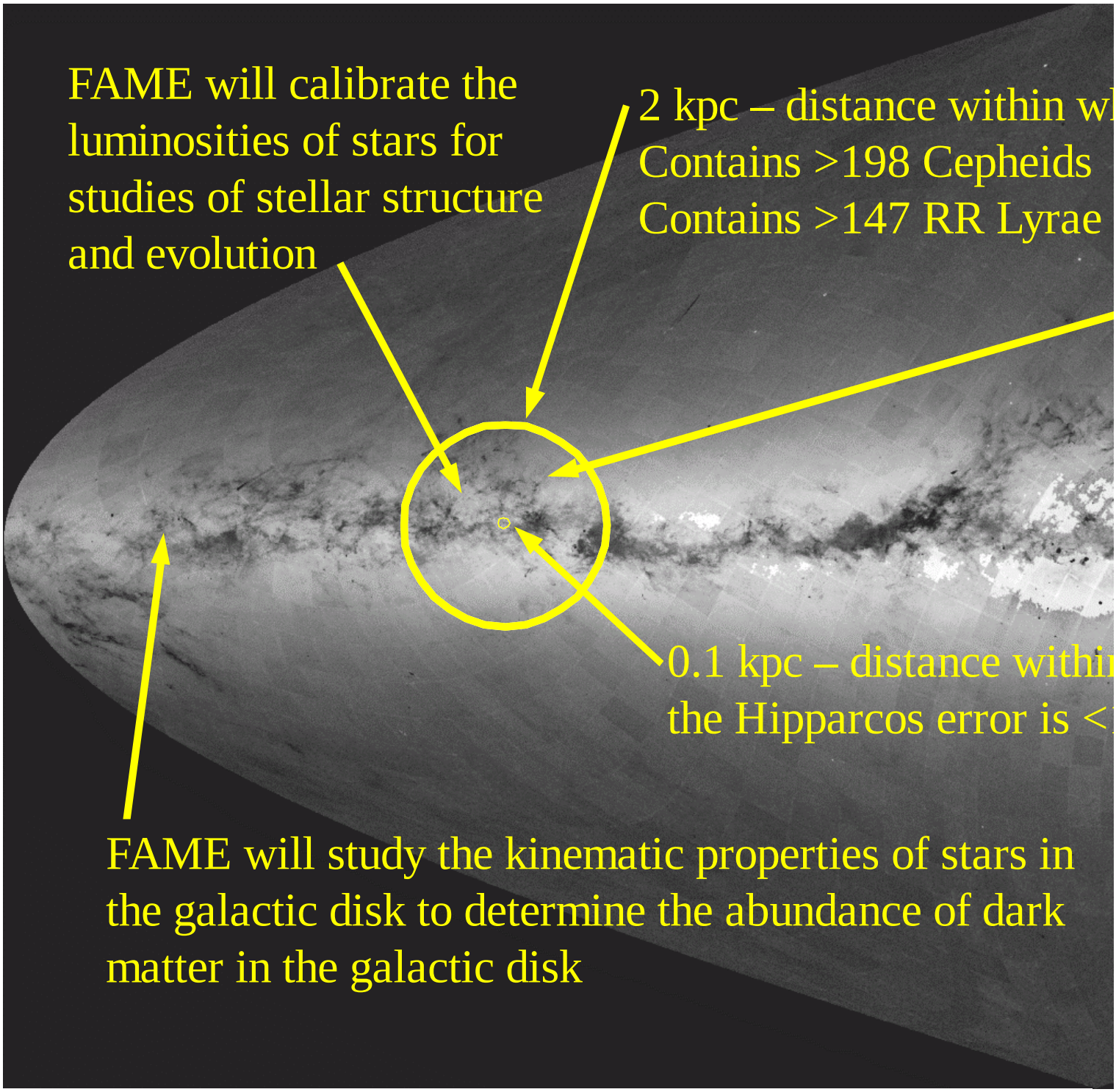
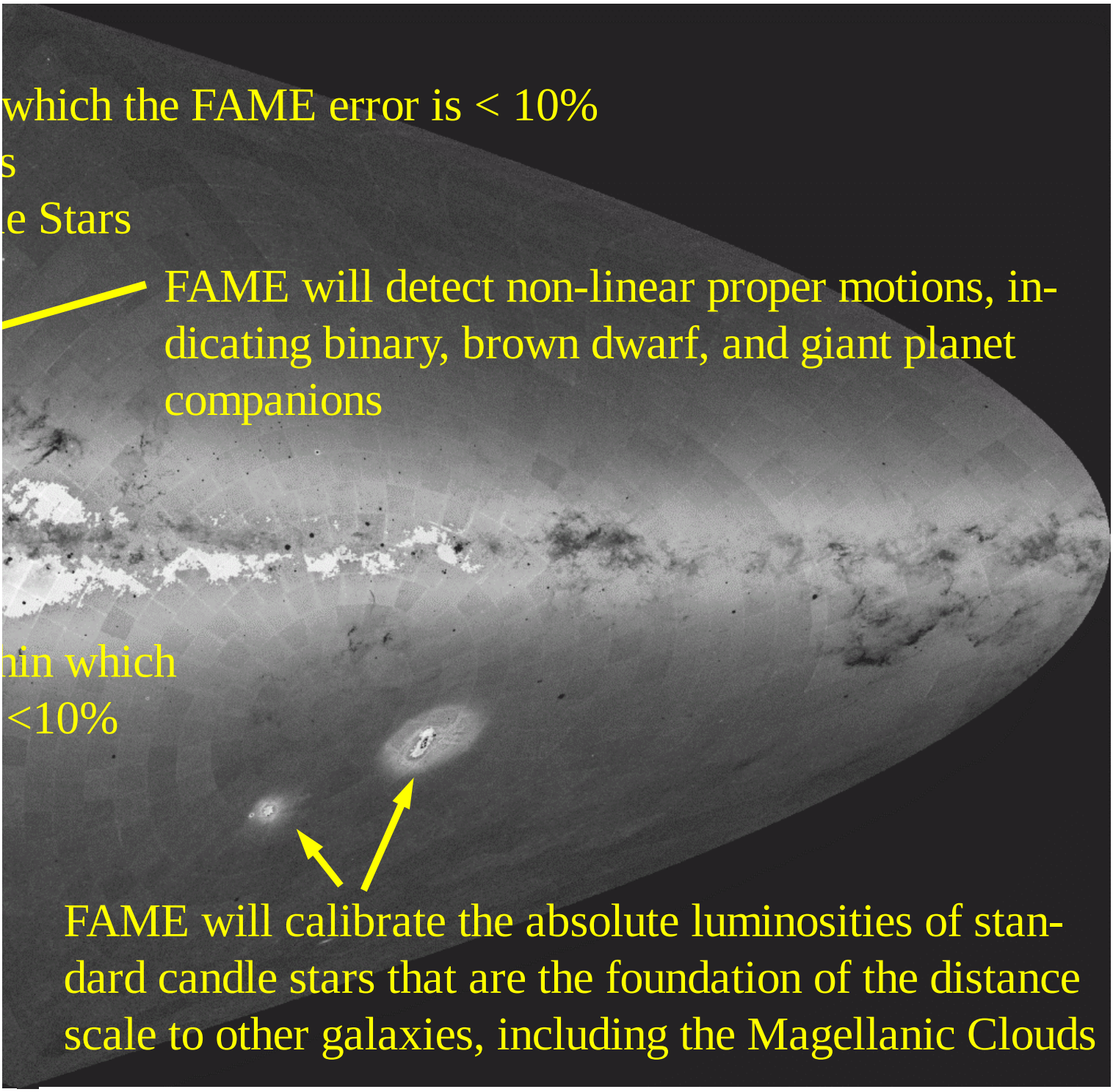


✦ Astrometry – positions, parallaxes, and proper motions of 40 million stars

✦ Extragalactic Distance Scale – accurately determine distances to “standard candle” stars fundamental in defining the distance scale



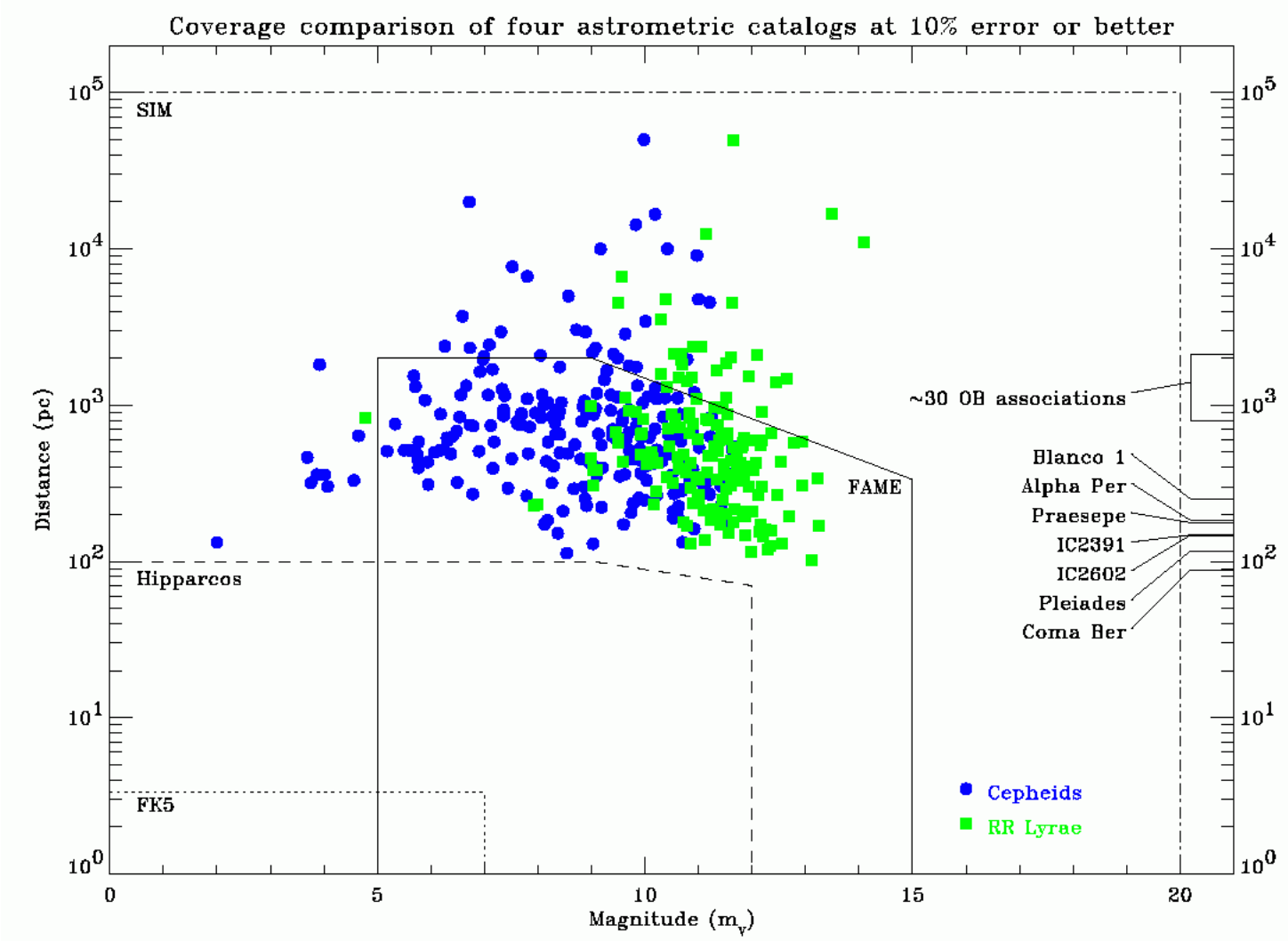
✦ Stellar Evolution – calibration of the absolute luminosities of solar neighborhood stars

✦ Stellar Companions – detect non-linear proper motions indicating companions with masses >10 M_{jup}

Full-sky Astrometric Mapping Explorer

- **Small satellite to perform an all sky, astrometric survey with unprecedented accuracy**
  - **Upgrades existing star catalogs by providing a precision catalog of 4×10^7 stars brighter than 15^{th} visual magnitude**
  - **Provides positions of all bright stars ($5 < m_v < 9$) to <50μas**
  - **Provides positions of fainter stars ($9 < m_v < 15$) to <300μas**
  - **2.5 year mission allows for accurate measurement of stellar parallaxes and proper motions**
  - **Photometric data in four Sloan DSS bands (g', r', i', z')**
- **Measure with 10% error or better the absolute trigonometric parallaxes, positions, and proper motions of stars brighter than 9^{th} visual magnitude within 2 kpc of the Sun**

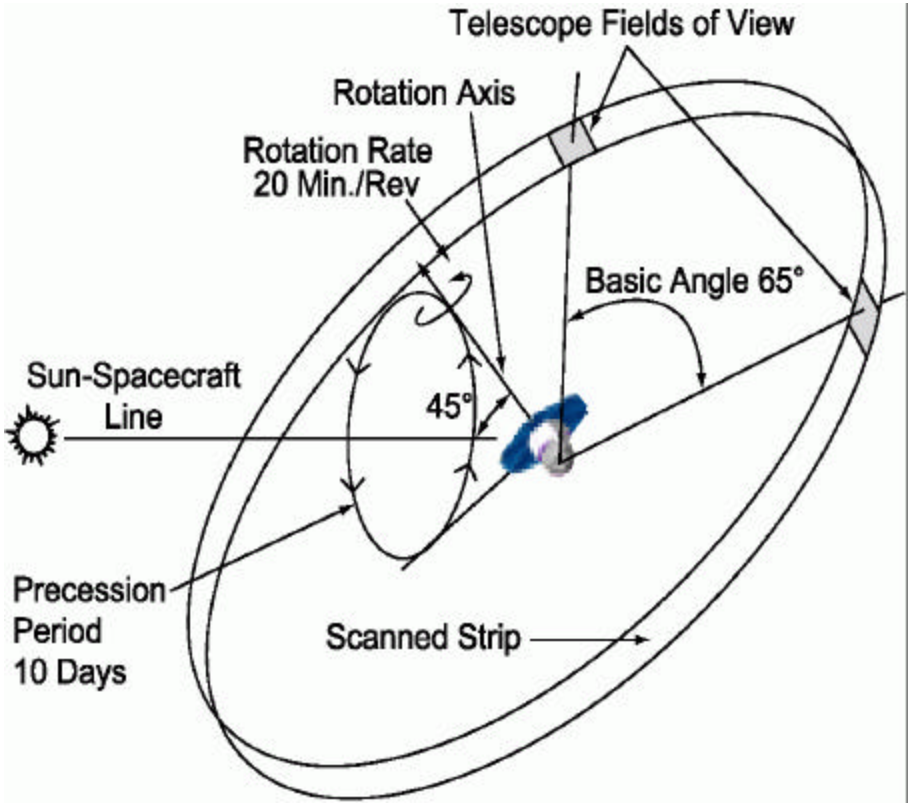
FAME Distance/Magnitude Limits and Standard Candle Stars



FAME observations of standard candle stars - For standard candle stars to serve as the foundation of the extragalactic distance scale, distances to the nearby stars need to be accurately determined. Hipparcos did not determine distances to these stars with a high level of accuracy. FAME is designed to determine distances accurate to 10% error or better to a large sample of Cepheids and RR Lyrae stars, thus refining the extragalactic distance scale. While SIM may obtain distances to some of these stars to better accuracy, SIM is a pointed mission that will only determine distances for a small number of known standard candle stars.

FAME Mission Description

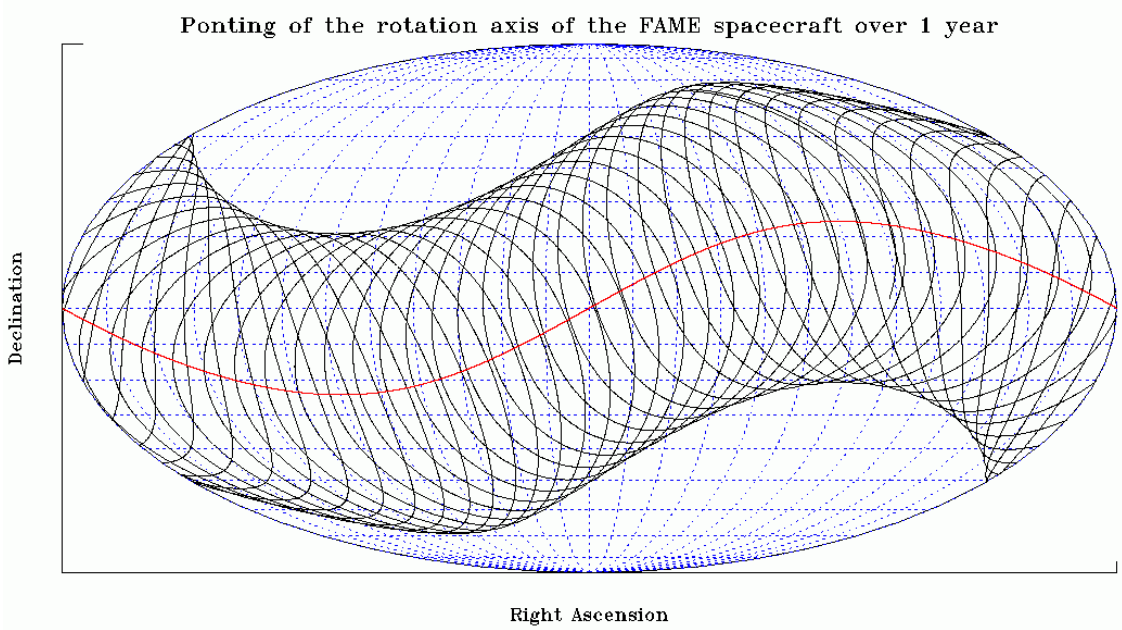
- The telescope has two fields-of-view separated by a 65° basic angle
- The spacecraft will rotate with a 20 minute period with the apertures sweeping out a great circle on the sky
- The spacecraft rotation axis is at a 45° angle to the Sun
- The solar radiation pressure on the solar shield results in precession about the Sun-spacecraft line with a 10 day period



The FAME observing concept - The axis of the FAME spacecraft is pointed 45° from the Sun and precesses around the Sun with a 10 day period. The FAME spacecraft rotates with a 20 minute period. The two fields of view are normal to the rotation axis and are separated by a 65° degree basic angle.

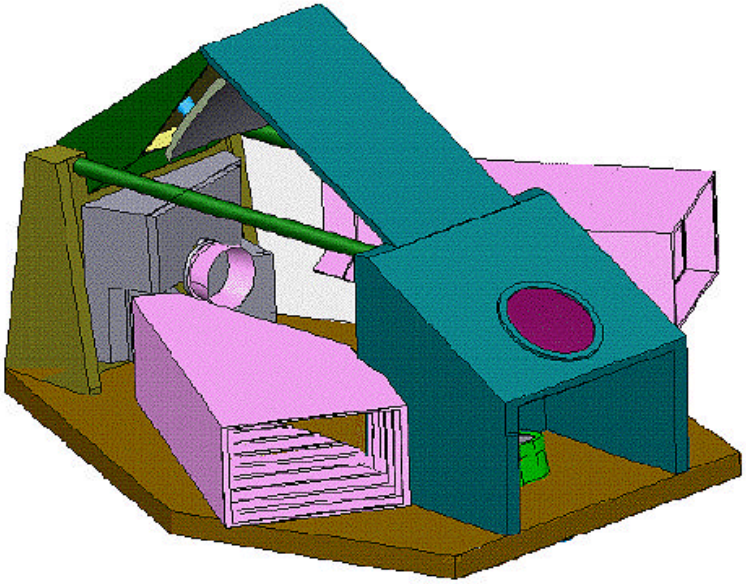
FAME Mission Description

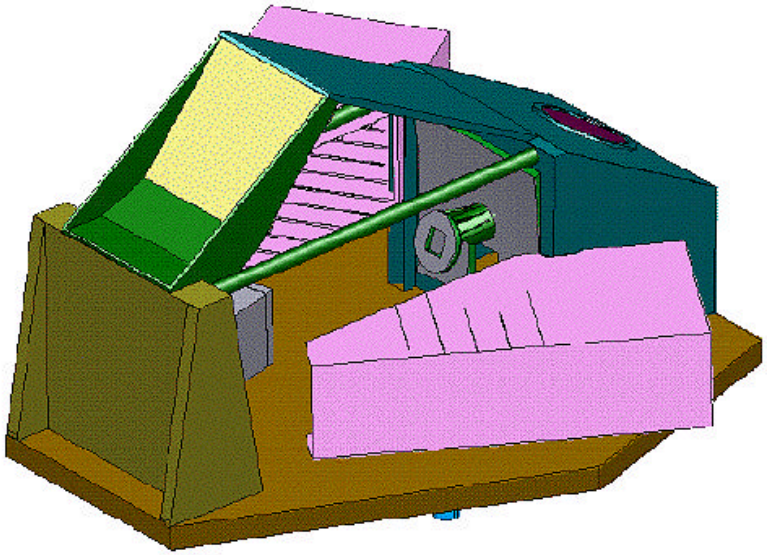
- Solar radiation pressure on the Sun shield produces a torque that precesses the spacecraft rotation axis
- This results in smooth precession resulting in long periods of coherent rotation
- The spacecraft rotation and precession, along with the orbit of Earth around the Sun, combine to give complete sky coverage over the course of 3 months



Pointing of FAME rotation axis - The spacecraft rotation axis precesses about the Sun with a 10 day period and a nominal Sun angle of 45°. Thus, every 10 days FAME covers the entire sky except for exclusion zones within 45° of the Sun and the anti-Sun direction.

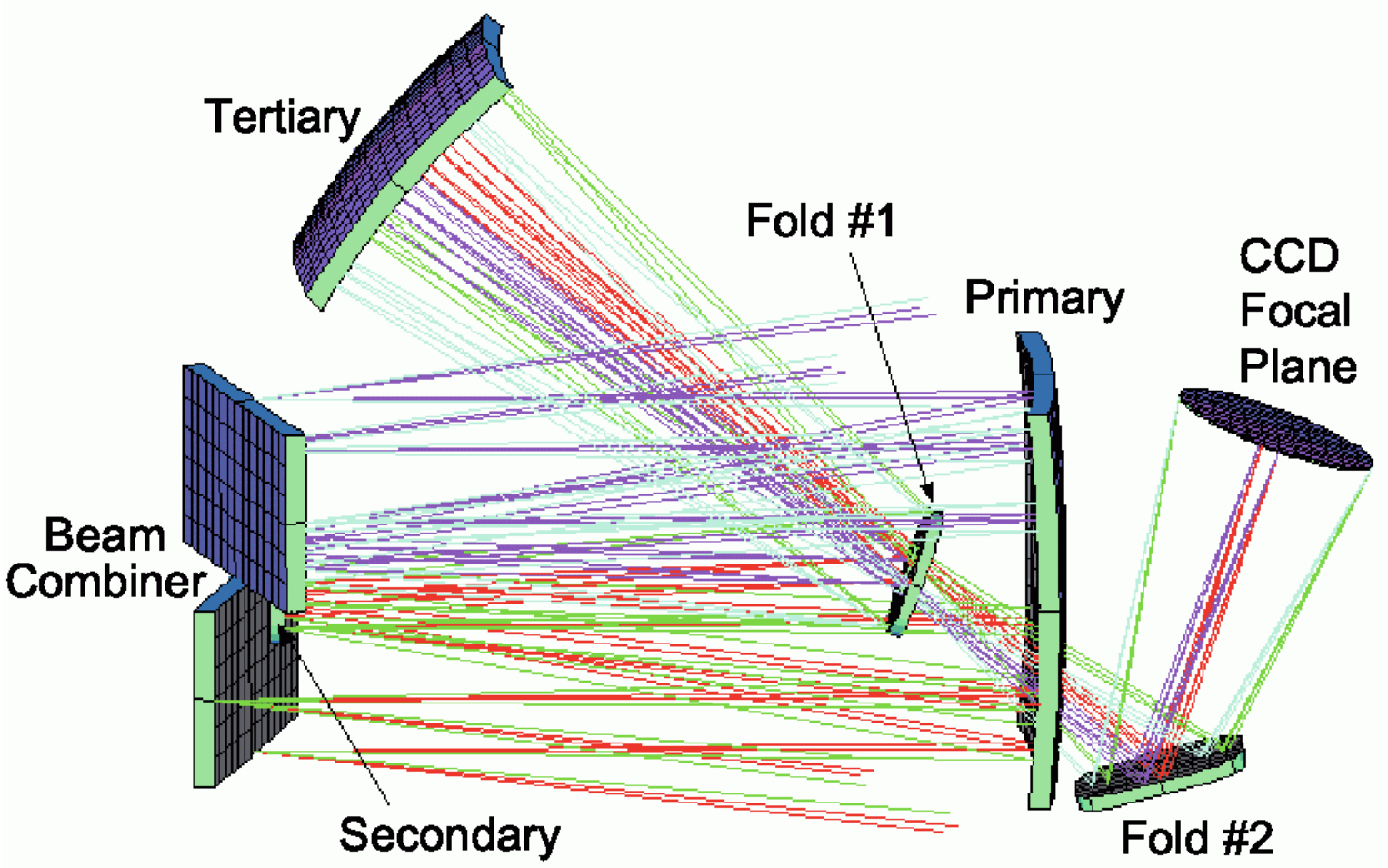
FAME Instrument Description





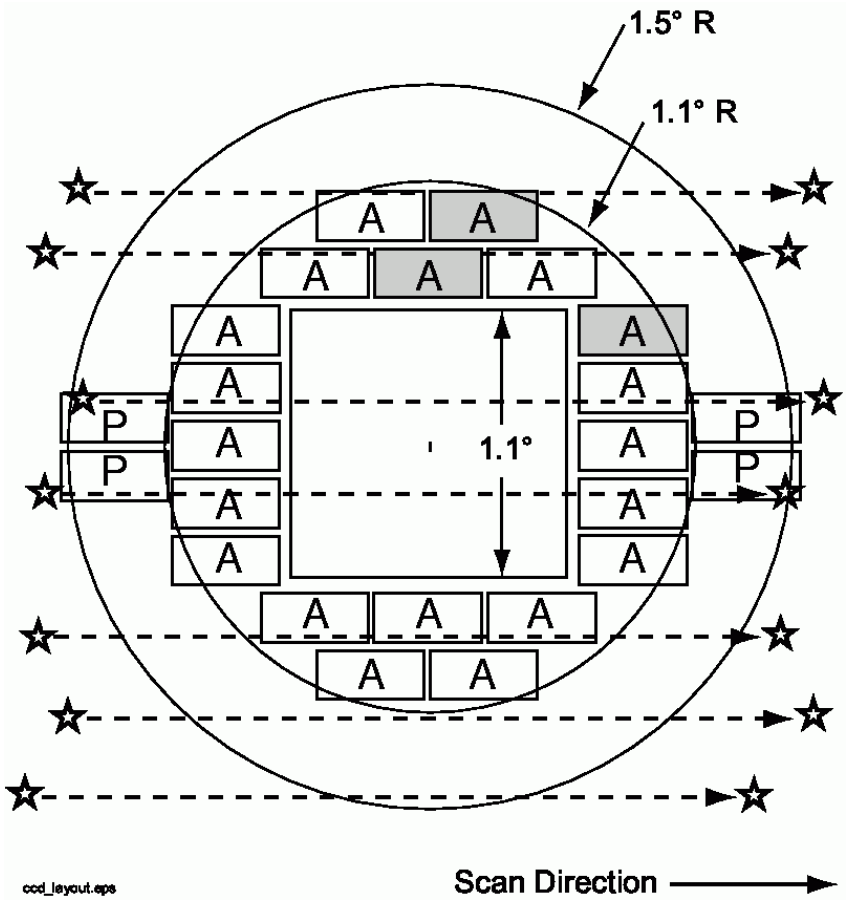
- Instrument developed by Lockheed Martin
- Total weight 165 kg
- Total power 250 W
- Instrument optics
  - Two input apertures
  - 50 25 cm aperture size (each)
  - 400 to 900 nm spectral range
- Back illuminated CCDs

FAME Instrument Description



FAME optical ray-trace diagram - The beam combiner gives the primary two fields of view, each with 50 25 cm apertures. The fields of view are separated by 65º on the sky. The two fields are then superimposed on the focal plane.

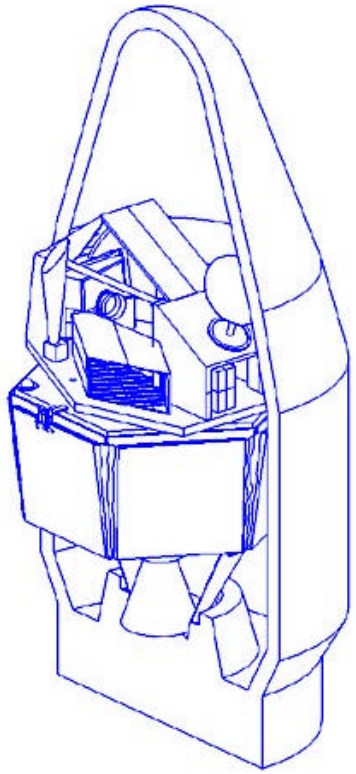
FAME Instrument Description



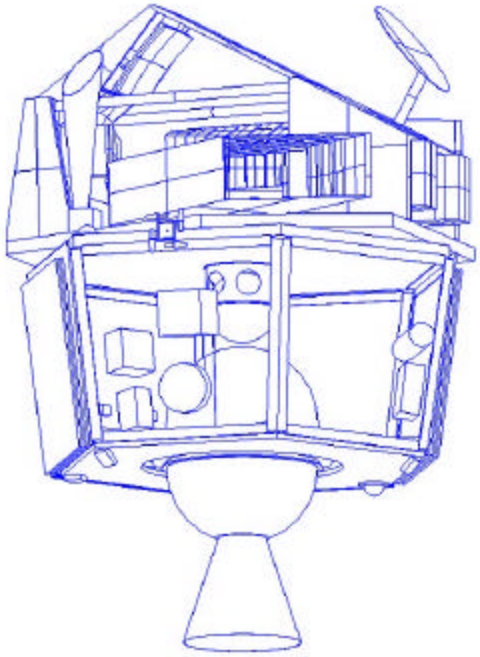
The FAME focal plane - 24 2k×4k CCDs arranged around a 1.1 ° radius from the center of the field of view. Devices marked with 'P' are the 4 photometric CCDs and devices marked with 'A' are the 20 astrometric CCDs. The 3 'gray' devices have neutral density filters for astrometry of brighter stars.

- **Telescope produces images of Stars using 24 large format CCDs**
  - **Images of stars are continually traversing CCD array as the spacecraft rotates**
  - **CCDs use time delay integration**
  - **Synchronization of CCD clock rate and image motion is assured via rotation rate sensors**
  - **Star images are time tagged, windowed, and transmitted to Earth.**
  - **3 CCDs are covered by neutral density filters for astrometry of bright stars**

FAME Spacecraft Bus Description

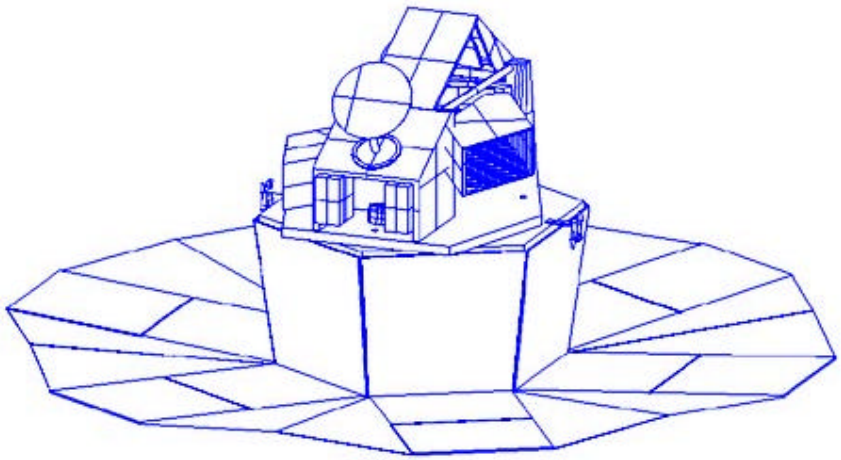


Spacecraft in Delta II 2.9m fairing



Spacecraft before solar shield deployment (cutaway)

Instrument cover removed for clarity in all views



On orbit configuration

✦Spacecraft design uses component heritage from Clementine

FAME Estimated Error Budget Totals

Visual Magnitude (m_V)	ND Filter Accuracy* (μas)	Gated Array Accuracy* (μas)
5	29	14
7	48	14
9	15	14
11	30	28
13	76	70
15	226	208

*Assumes systematic error contribution is 10 μas

The FAME accuracy - The predicted accuracy of FAME as a function of visual magnitude (m_v). The second column shows the accuracy if neutral density filters over 3 of the astrometric CCDs are used for astrometry of the brighter stars (baseline design). The third column shows the accuracy if the CCDs are only integrating during part of the time when a bright star is traversing the device (alternate design).

Conclusion

- FAME has been proposed as a NASA MIDEX mission to determine accurate positions, parallaxes, and proper motions for 40 million stars
- Recalibrates the extragalactic distance scale
- Determines absolute luminosities of a wide range of spectral types
- Detects companion stars, brown dwarfs, and giant planets
- Enable studies of the kinematics of our galaxy
- Define an optical reference frame for future scientific, commercial, and military endeavors